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Mg, Ba and Eu abundances in thick disk and halo stars

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Abstract

Our sample of cool dwarf stars from previous papers (Mashonkina & Gehren 2000, 2001) is extended in this study including 15 moderately metal-deficient stars. The samples of halo and thick disk stars have overlapping metallicities with [Fe/H] in the region from -0.9 to -1.5, and we compare chemical properties of these two kinematically different stellar populations independent of their metallicity. We present barium, europium and magnesium abundances for the new sample of stars. The results are based on NLTE line formation obtained in differential model atmosphere analyses of high resolution spectra observed mainly using the UVES spectrograph at the VLT of the European Southern Observatory. We confirm the overabundance of Eu relative to Mg in halo stars as reported in our previous papers. Eight halo stars show [Eu/Mg] values between 0.23 and 0.41, whereas stars in the thick and thin disk display a solar europium to magnesium ratio. The [Eu/Ba] values found in the thick disk stars to lie between 0.35 and 0.57 suggest that during thick disk formation evolved low-mass stars started to enrich the interstellar gas by s-nuclei of Ba, and the s-process contribution to barium thus varies from 30% to 50%. Based on these results, and using the chemical evolution calculations by Travaglio et al. (1999), we estimate that the thick disk stellar population formed on a timescale between 1.1 to 1.6 Gyr from the beginning of the protogalactic collapse. In the halo stars the [Eu/Ba] values are found mostly between 0.40 and 0.67, which suggests a duration of the halo formation of about 1.5 Gyr. For the whole sample of stars we present the even-to-odd Ba isotope ratios as determined from hyperfine structure seen in the Ba II resonance line λ4554. As expected, the solar ratio 82:18 (Cameron 1982) adjusts to observations of the Ba II lines in the thin disk stars. In our halo stars the even-to-odd Ba isotope ratios are close to the pure r-process ratio 54:46 (Arlandini et al. 1999), and in the thick disk stars the isotope ratio is around 65:35 (±10%). Based on these data we deduce for thick disk stars the ratio of the s/r-process contribution to barium as 30:70 (±30%), in agreement with the results obtained from the [Eu/Ba] values.

Keywords

Abundances, Galaxy: evolution, Line: formation, Nuclear reactions, Nucleosynthesis, Stars: abundances, Stars: late-type